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# THE UNIVERSITY OF MICHIGAN

## COLLEGE OF ENGINEERING
Computer, Information and Control Engineering Program

FINAL TECHNICAL REPORT

15 September 1975 - 14 July 1980

Grant No. AFOSR-76-2905 (With Extensions)

September 15, 1975 to July 14, 1980

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Prepared by

Frederick J. Beutler
Principal Investigator

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The activities supported by the Grant have been well documented by numerous publications ([1] to [16]) and the attendant DD-1473 forms, in addition to regular Annual Status Reports ([17] to [20]) describing conference presentations and incomplete studies. Consequently, this Final Technical Report is limited to a brief categorization by research area and research personnel, with appropriate reference to the relevant technical content of the advances produced with the assistance of the subject Grant.

Since its inception, the subject Grant has been largely concerned with investigations on Markov queueing networks; even though the Markov property provides a powerful analytical tool, many of the fundamental parameters--e.g., customer streams, waiting times, transient behavior, sojourn times--were poorly understood. Jackson networks, which perhaps constitute the simplest kind of queueing system, were considered first [17][18]. Results on conditions for line length equilibrium, and related service times and number of services per customer were soon obtained [11][2].
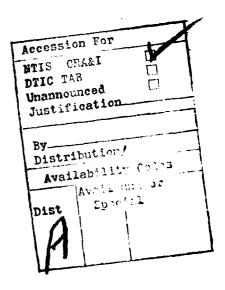
It was noted that the line length vector describing the Markov system could be augmented to incorporate generalized forms of traffic counts. This led to studies on and identification of Poisson traffic flows on broad classes of queueing networks. Publication of these studies embraced almost the entire Grant period, and include [1] [5][6][7][10][12][13][14].

Another area of research has been the routing and service optimization of queueing networks, as described in [18][19][20][8]. This effort was carried out principally by Mr. William Hortos, who was supported by the Grant, and whose dissertation is now virtually complete.

In addition, the Grant has afforded support to several other doctoral students engaged in dissertation research. We have already mentioned the publications of Dr. Benjamin Melamed [1][2] [7][10][12][14], who has since developed into a successful researcher on his own. Dr. Burt Simon worked partly under the direction of the principal investigator also [16][19], ultimately completing his dissertation elsewhere with the guidance of Professor Ralph

Disney. Some Grant funds were further expended to aid other doctoral students. Mr. Flavio Rose attempted to show that a Jackson network possesses the geometric ergodicity property [19]; although he failed, he proved to be a brilliant investigator. His studies are continuing at M.I.T. Less fortunate was Mr. Fang-Fei Hsu, who worked on the Grant in 1979, but soon showed himself inadequate as a doctoral student. During its final months, the Grant aided Mr. Mohammad Mobed, who was beginning his doctoral research. Mr. Mobed is presently continuing his research on queueing networks with the principal investigator with support from another source.

The principal researcher was active also in research on other aspects of queueing networks. He devised a general yet tractable model for a large class of Markov queueing networks [4], considered the applicability of generalized forms of Little's formula to Markov queueing networks [9][15], and studied the output flow of feedback general servers with a finite waiting room [11]. Finally, the principal investigator presented two invited papers on queueing networks [5][6] in addition to the items previously mentioned.

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